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SOME OBSERVATIONS AND EXPERIENCES IN THE OPERATION OF COAGULATING BASINS

By James W. Armstrong

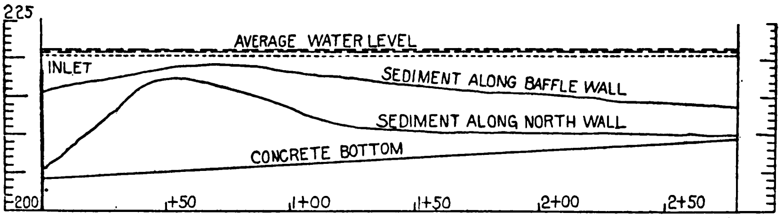
The two coagulating basins of the Montebello filters of the Baltimore water works are each 317 feet long, 232 feet wide and have an average depth of water of about 15 feet. A central baffle wall extends about three-quarters of the length of each basin. Water is admitted through five sluice gates, spaced at equal intervals, and after passing around the baffle, is withdrawn through a similar number of gates. The water passes over a baffle at the entrance and over a skimming wier at the exit. It was the hope of the designer that the water would move with reasonable uniformity through the basins, but this has not been realized.

In the course of operation it was noticed that the movement of water through each of the two coagulating basins was different, although they were operated in parallel and apparently under the same conditions. It was also noticed that the water, while following characteristic lines in each basin, seemed to vary from time to time.

In order to learn something more definite regarding the exact movement of the water and its effect on the efficiency of the basins, a series of sixteen different current measurements was made. For making the observation, six identical aluminum floats were used. Each float was cross-shaped in plan and was composed of four sheets of aluminum each 6 by 12 inches, inserted in a pine strip. The floats were just heavy enough to half submerge a large cork, to which a number was pinned. The portions of the floats exposed to the wind were very small, and as the observations were not made on windy days, it is believed that their movements indicate the currents through the basin with reasonable accuracy. Most of the observations were made with the floats submerged just below the surface or 4 feet below.

The floats were started at the entrance of the basin and readings were taken, locating their position, every six minutes. The floats in the main channel, both surface and at the 4 foot depth, generally moved forward at relatively high velocities, while those along the outer edges of the basin moved in very erratic ways, sometimes getting caught in eddies in the corners and staying there for hours. Basin 1 usually showed an eddy at the entrance in the northwest corner, probably due in part to a slight difference in the alignment of the baffle. Basin 2 showed no eddies at the entrance, but both basins showed eddies in the far corners and usually along the outlet side of the baffle wall.

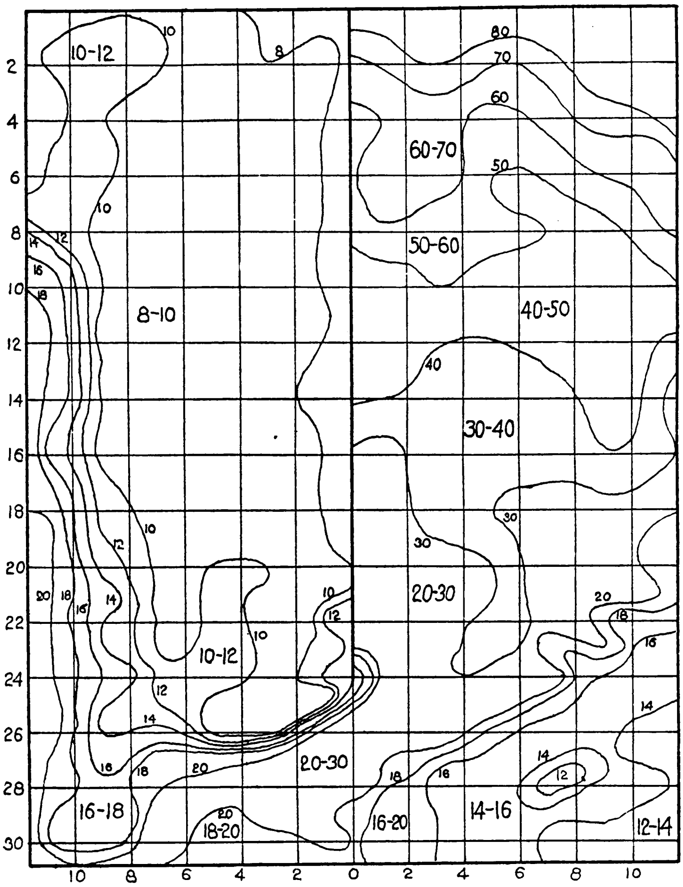
On August 14, 1917, surface floats were used for making current measurements in basin 1. The velocity of the floats varied considerably. Some of them moved *forward* at rates as high as 32 feet per minute. On the outlet side of the baffle, two of them were carried *backward*, adjacent to the baffle for three-quarters of its length. On August 18, 1917, the basin was cleaned and on August 21 other surface float measurements were made. On this occasion the floats moved along entirely different lines. One of them circled around in the northwest corner, the other four moved slowly along the baffle wall at velocities of from 2 to 12 feet per minute, and on the outlet side of the baffle showed no decided forward movement.



Sediment in Basin 1 on May 25, 1916

The greater velocity and more uniform movement of floats on August 14 was due to the fact that mud had filled the lower part of the basin, necessitating higher surface velocities. Most of the float measurements showed that higher velocities were obtained near the baffle wall on the incoming side and the outer wall on the outgoing side. A survey of the mud surface just before cleaning showed that the heaviest deposits followed approximately the lines of maximum velocity of flow, and that the greatest depth of deposit was at a point a little over 50 feet from the entrance. The corners where eddies occurred had the least depth of mud.

On August 16, 1917, two days before cleaning the basin, a turbidity survey of basin 1 was made. Readings were taken at intervals of 10 feet, with a United States Geological Survey turbidity rod. The heaviest turbidities were observed at the entrance, and from there they decreased along pretty well defined but irregular lines toward the rear of the first half of the basin. In the second half of the basin the maximum turbidities followed approximately the lines of greatest velocity. This test seemed to indicate that the velocity at the entrance was too high to secure

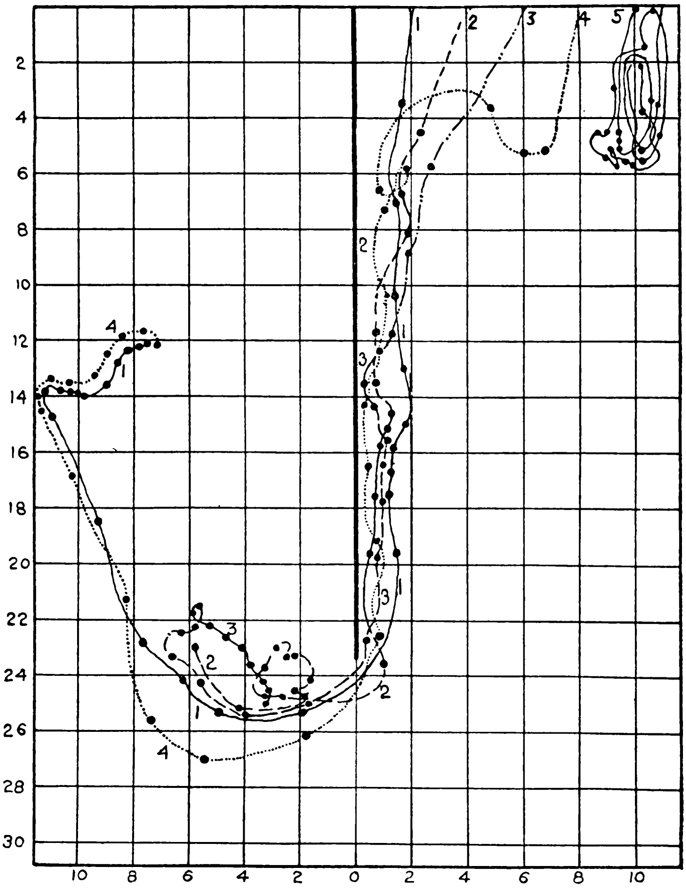


SURFACE TURBIDITY MEASUREMENTS, BASIN 1

Readings taken with U. S. G. S. turbidity rod; Venturi rate of flow 115 m.g.d.; August 16, 1917.

the best subsiding value and that uniform velocities are necessary for uniform subsidence.

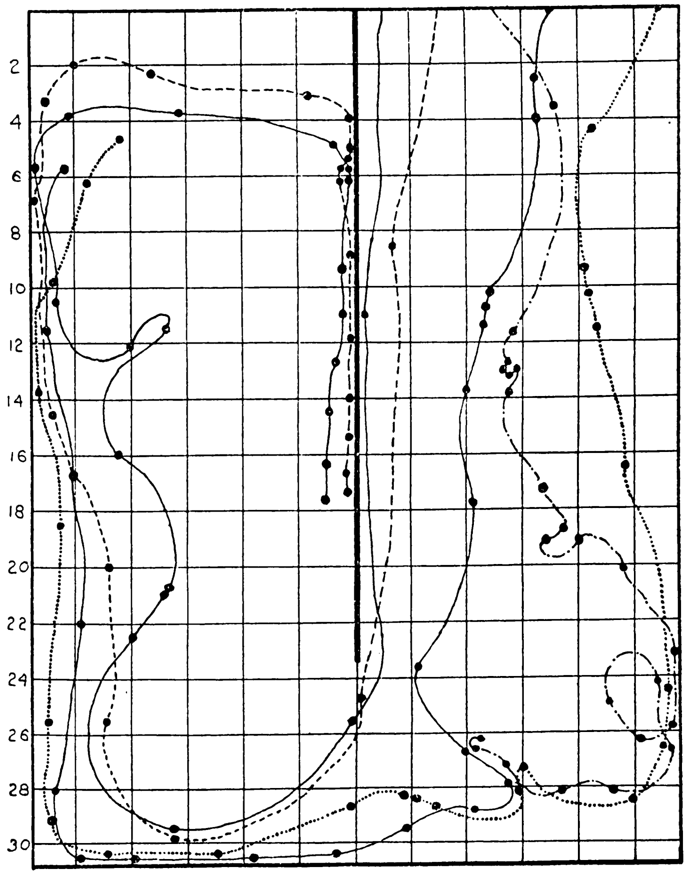
At one time, for a short period only, the bacterial counts were slightly higher in the effluent from the coagulating basins than in the raw water. The increase of growth in the basins led to the belief that bacteria were multiplying in the places where the currents were sluggish and were being gradually swept into the main current and carried to the filters.



Current Measurements with Surface Floats, Basin 1

Readings of floats taken every five minutes; Venturi rate of flow 123 m.g.d. August 21, 1917.

In order to test the accuracy of this theory, several careful bacterial surveys were made. Numerous samples were taken at points showing the greatest difference of turbidity and velocity. One set was taken near the surface and another at a depth slightly above the mud line. The samples taken near the entrance of the basin showed slightly higher counts than those taken at other places, but none of the results showed any evidence of increased growth in any part of the basin.

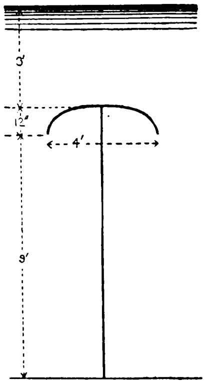


CURRENT MEASUREMENTS WITH SURFACE FLOATS, BASIN 2

Reading of floats taken every five minutes except first reading on each float which had six minutes interval; Venturi rate of flow 128 m.g.d.; August 14, 1917.

In addition to the variations in velocity and the lack of uniformity in mud deposits, other irregularities were noticed in the functioning of the basins. As an illustration, it was noted on one occasion that basin 1 gave decidedly better results than basin 2, but upon making a slight change in the opening of one of the inlet gates, the condition was shortly reversed and basin 2 gave markedly better results than basin 1.

This phenomenon raised the question as to the possible effect of undercurrents upon the subsiding value of the basins. It was argued that if the elements of water in moving through the basin could be kept in nearly parallel lines and if the movement could be confined to the surface of the water, leaving the lower stratum undisturbed, much greater subsiding value could be obtained.



Wooden Baffle Across Basin 1

With the purposes of testing out this theory, some modifications were made in the existing entrance baffle, and an additional cross baffle was built in basin 1. In order to give a positive outward sweep to the water entering the basin, increase the surface velocity, and prevent returning undercurrents, a wooden apron about 2 feet wide and sloping in an upward direction was attached to the top of the existing entrance baffle. At the end of the existing concrete baffle, about 240 feet from the entrance, an additional wooden baffle was built entirely across the basin. No changes were made at the outlet skimming wier. The new baffle was 10 feet high and was capped with a top 4 feet wide, which projected 2 feet on each side. The top was curved downward at the ends in the form of a parabola. Water usually flowed about 3 feet deep over the top of the baffle.

The following reasoning was responsible for the building of the unusual type of cross baffle.

The reduction of the cross sectional area would tend to establish a more uniform flow across the top of the basin and create a quiet zone near the bottom that would permit better sedimentation. It was well known that when flowing water meets an obstruction such as a baffle, there is a decided tendency to pick up sediment and carry it over the top, and it was argued from the known characteristic of a parabola to reflect rays of light in parallel lines, that the sediment in the rising currents of water, would, upon striking the parabola, be thrown downward and deposited, instead of being carried over into the next compartment. The curved top over the rear of the baffle is only useful in gradually reducing the velocity of water flowing over the top.

After this baffle had been in service for a number of months, the basin was cleaned. It was found that the apron extending across the top of the baffle at the entrance of the basin had been built a little too near the surface, and the velocity of entering water was so great that it carried most of the sediment outward as far as the cross baffle. The results at the cross baffle, however, were most gratifying. The parabolic top had evidently acted exactly as had been anticipated, for the mud was deposited adjacent to the baffle, almost to its full height, and sloped gradually backward to the entrance of the basin. The baffle on the return side had not performed so well, probably owing to the fact that the water in passing over it was not flowing in a direction normal to its face. It is believed that if this baffle had been placed about 70 feet nearer the outlet, it would have worked better.

As soon as the opportunity is afforded the apron controlling the incoming water will be lowered so as to decrease the velocity at the entrance, and the baffle on the outgoing side will be removed forward. It is hoped that then the sediment will be deposited more uniformly.

This hopeful but imperfect experiment is made public with the thought that it may stimulate others to make further experiments or lead them to publish information which they already have.